Department of Electrical Engineering
Assignment
Date: 14/04/2020

Course Details

Course Title: Power Electronics
Instructor:
Module:
Total Marks: 30

Student Details

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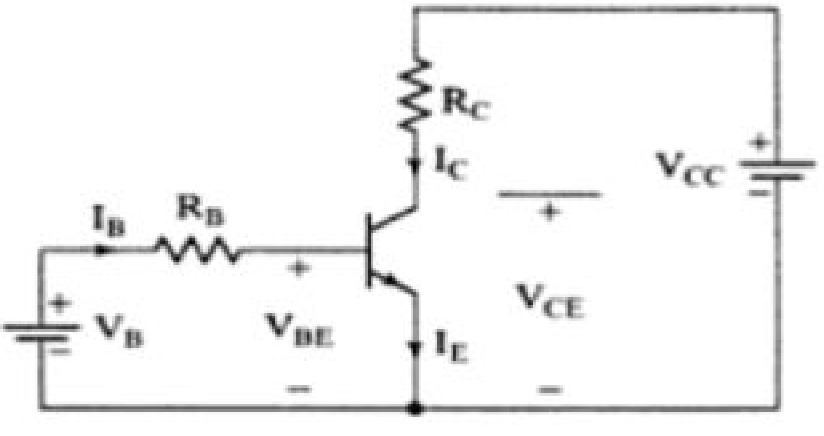
Note: Plagiarism of more than 20% will result in negative marking.
Similar answers of students will result in cancellation of the answer for all parties.

Q1.	(a)	An appliance circuit has a R-L connected in series with a diode. After some time, modification is done to the circuit and a free-wheeling diode in added in parallel to the R-L. Will it have any impact on the performance and output of the circuit. Back your answer with before & after data, facts and figures. Does adding a free-wheeling diode in parallel to a R-C circuit have the same effect, different effect or no effect.	Marks 7 CLO 1
	(b)	A Power Mosfet is connected in a circuit. The Drain to Source voltage, V_{DS} = (Last 2 digits of your student ID) V and Threshold Voltage, V_T = (Last 1 digits of your student ID) V. What is the minimum Gate to Drain Voltage, V_{GS} required for the P.Mosfet to be in saturation mood.	Marks 3 CLO 1
Q2.	(a)	A Power Electronics appliance of 500W, 220V, 500KHz rating is using a Power Mosfet for switching purpose. If the P.Mosfet is replaced with a Power Bipolar Junction Transistor what effect will it have on the performance, losses and efficiency of the appliance. Will any other changes to the circuit be required? Back your reasons with valid data, facts and figures.	Marks 5 CLO 1
	(b)	In the above appliance (Q2.a) if the P.Mosfet is replaced with a Silicon Controlled Rectifier what effect will it have on the performance, losses and efficiency of the appliance. Will any other changes to the circuit be required? Back your reasons with valid data, facts and figures.	Marks 5 CLO 1
Q3.	(a)	The bipolar transistor in the Figure below is specified to have β_F in the range of 8 to 40. The load resistance, R_C = (Last 2 digits of your student ID) Ω.	Marks 10
		The dc supply voltage, V_{CC} = (Last 3 digits of your student ID) V and the input voltage to the base circuit, V_B = 10 V. If V_{CE} = (First digits of your student ID) V and V_{BE} = 1.5 V, find (a) The mode of operation of the transistor (b) the value of R_B that results in saturation with an ODF of 5, (c) the β_{forced}, (d) the power loss, P_T in the transistor.	CLO 1
			

Answer Sheet

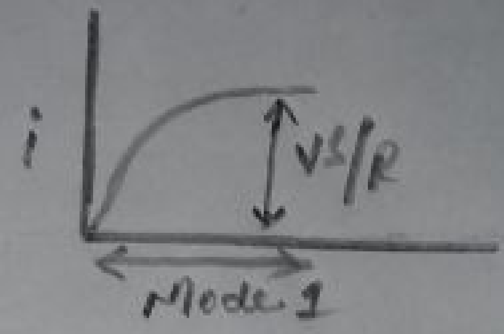
(1)

Q # 1(a) An appliance circuit has a R-L load connected in series with diode. when free wheeling diode is added in parallel to R-L load. Then it will only reduced the ripple & prevent the load current from leading to zero. And it has no sense on half wave rectification.
Secondary if R-C circuit load is taken instead of R-L then the effect will be same. The only diffrence will be the load voltage & it can be prevented from tending to zero.

In R-L load when switch is (ON) the inductor stores energy (current). And at that time the current is flown in the circuit is

$$i = \frac{Vs \cdot e^{-R/Lt}}{R}$$

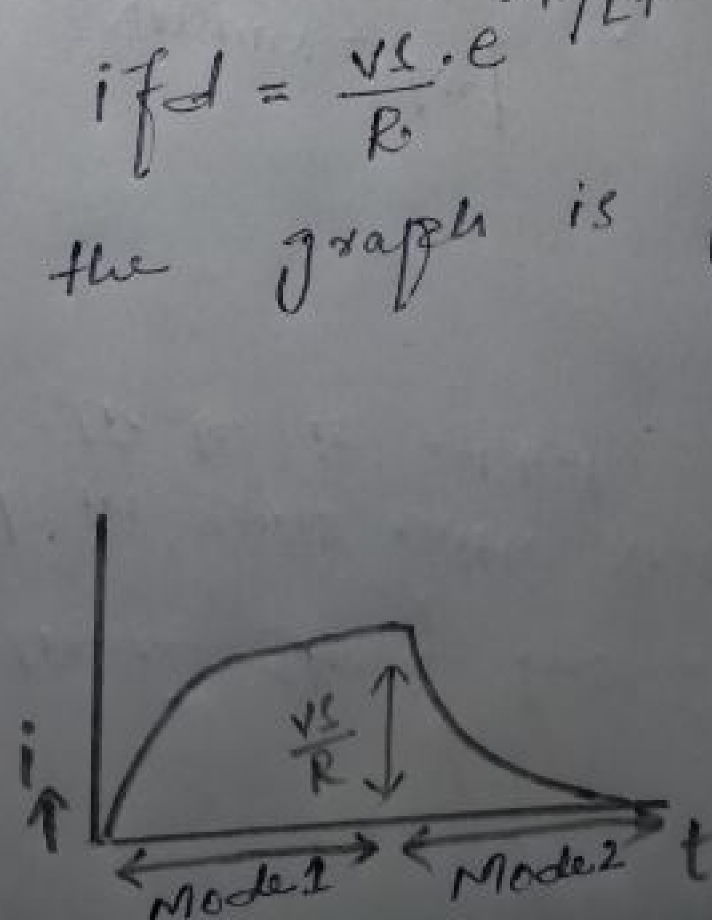
& the energy stored in the inductor is equal to $1/2\, L (Vs/R)^2$
And the graph is given below



And when the switch is OFF current start flow from inductor & passes through the free-wheeling diode. The output current is not zero completely. It will gradually decrease to zero. And the free-wheeling diode current at that time is

$$i_{fd} = \frac{Vs}{R} \cdot e^{-R/L t}$$

And the graph is given below



Q#2 (a) A power electronics appliance of 500W 220V & 500 kHz is rating is using power Mosfet for switching purpose. If mosfet is replaced with BJT then switching losses will be increased. Because in BJT switching losses is directly proportional to frequency. If losses increase the performance will decrease. Secondly due to losses heat increases it may damage the BJT & appliance too.
So overcurrent & over voltage protection are necessary but along this a snubber circuit is also compulsory to limit the fluctuation in the voltage.

Q#2 (b) If Mosfet is replaced with silicon controlled rectifier (SCR) that the effect will be given as below

An SCR experience four types losses

1) ON-State losses 2) OFF-State losses
3) Switching losses 4) Gate trigger losses

Besides all the other losses if, we take switching losses then the switching losses of (SCR) silicon controlled rectifier are very less below the 4KHZ frequency. But if frequency increases losses also increases.

It means that SCR also reduced the performance & effiency.

So, we should restricted to the use of MOSFET.

5

Q#3

GIVEN:

$V_{CC} = 437v$ (last 3 digits ID)

$V_B = 10v$

$V_{CE(sa)} = 11$ (first 2 digits ID)

$V_{BE} = 1.5v$

~~$R_C = 4$~~

$R_C = 37$ (last 2 digits ID)

Required:

1) Mode of operation of the transistor.
2) Value of RB that results in saturation with an ODF of 5.
3) B forced.
4) power loss P_T in the transistor.

SOLUTION:

As we know

$$I_{CS} = \frac{V_{CC} - V_{CE(sa)}}{R_C}$$

$$= \frac{437 - 11}{37}$$

(6)

$$I_{CS} = 11.51\ A$$

Therefore

$$I_{BS} = \frac{I_{CS}}{I_{B\,min}}$$

$$I_{BS} = \frac{11.51}{8}$$

$$I_{BS} = 1.43\ A$$

So

$$I_B = ODF \times I_{BS}$$

$$= 5 \times 1.43$$

$$I_B = 7.1\ A$$

$$I_B = \frac{V_B - V_{BE(sa)}}{R_B}$$

$$R_B = \frac{V_B - V_{BE(sa)}}{I_B}$$

$$R_B = \frac{10 - 1.5}{7.1}$$

$$R_B = 1.19\ \Omega$$

Part(B)

$$\beta_f = \frac{I_{CS}}{I_B}$$

$$= \frac{11.51}{7.1}$$

$$\boxed{\beta_{force} = 1.62}$$

Part(C)

$$P_T = V_{BE} I_B + V_{CE} I_C$$

$$= 1.5 \times 7.1 + 11 \times 11.51$$

$$= 10.65 + 126.61$$

$$\boxed{P_T = 137.26\ W}$$